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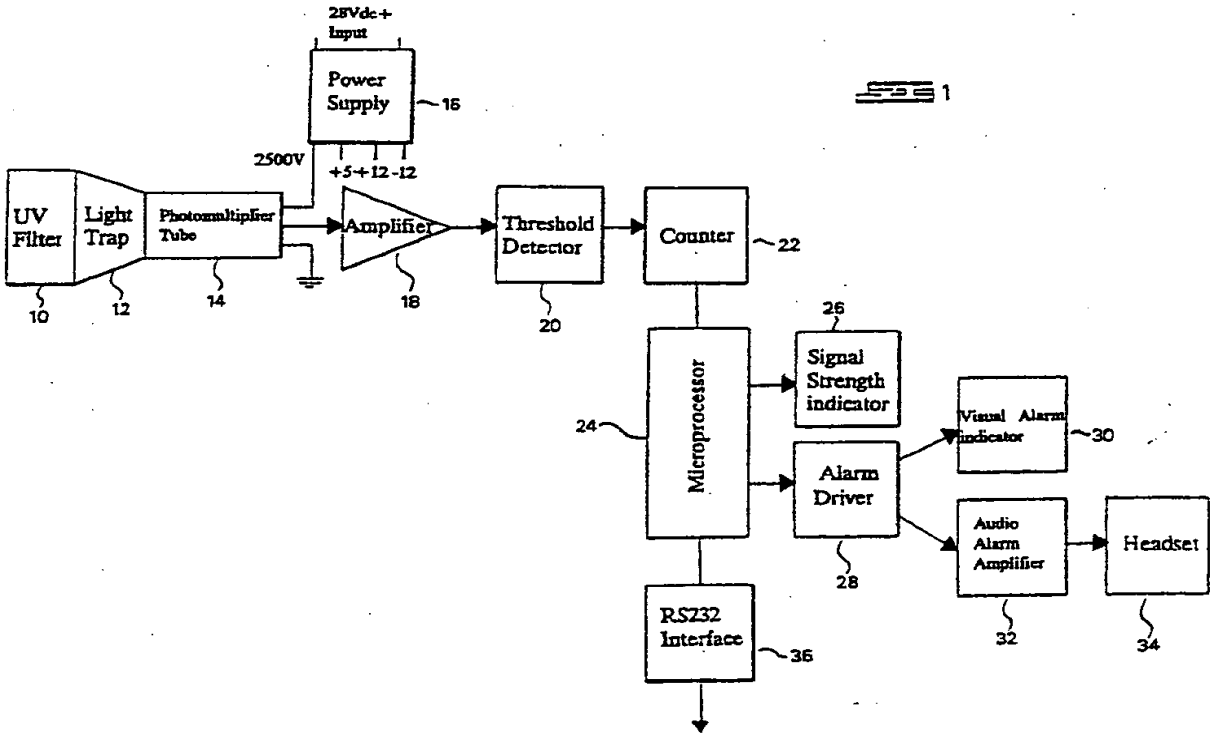
(56) Documents Cited
US 5021668 A US 4898465 A US 4516022 A

(58) Field of Search
UK CL (Edition L) G1A AHC AHP AHS AMS
INT CL[5] G01J
Online database :WPI

(54) Optical detection of electrical discharges

(57) Apparatus for detecting electrical discharges from power lines comprises an optical filter (10) which passes energy in the ultraviolet portion of the spectrum due to electrical discharges, but blocks ambient solar energy. A photomultiplier tube (14) amplifies the energy passed by the filter, and an amplifier (18) is used to generate an electrical signal indicative of the discharges which is large enough to process. A discriminator circuit (20) detects peaks corresponding to discharges, and determines the kind of discharge from the timing between detected peaks. A visible and audible indication of detected peaks is provided.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

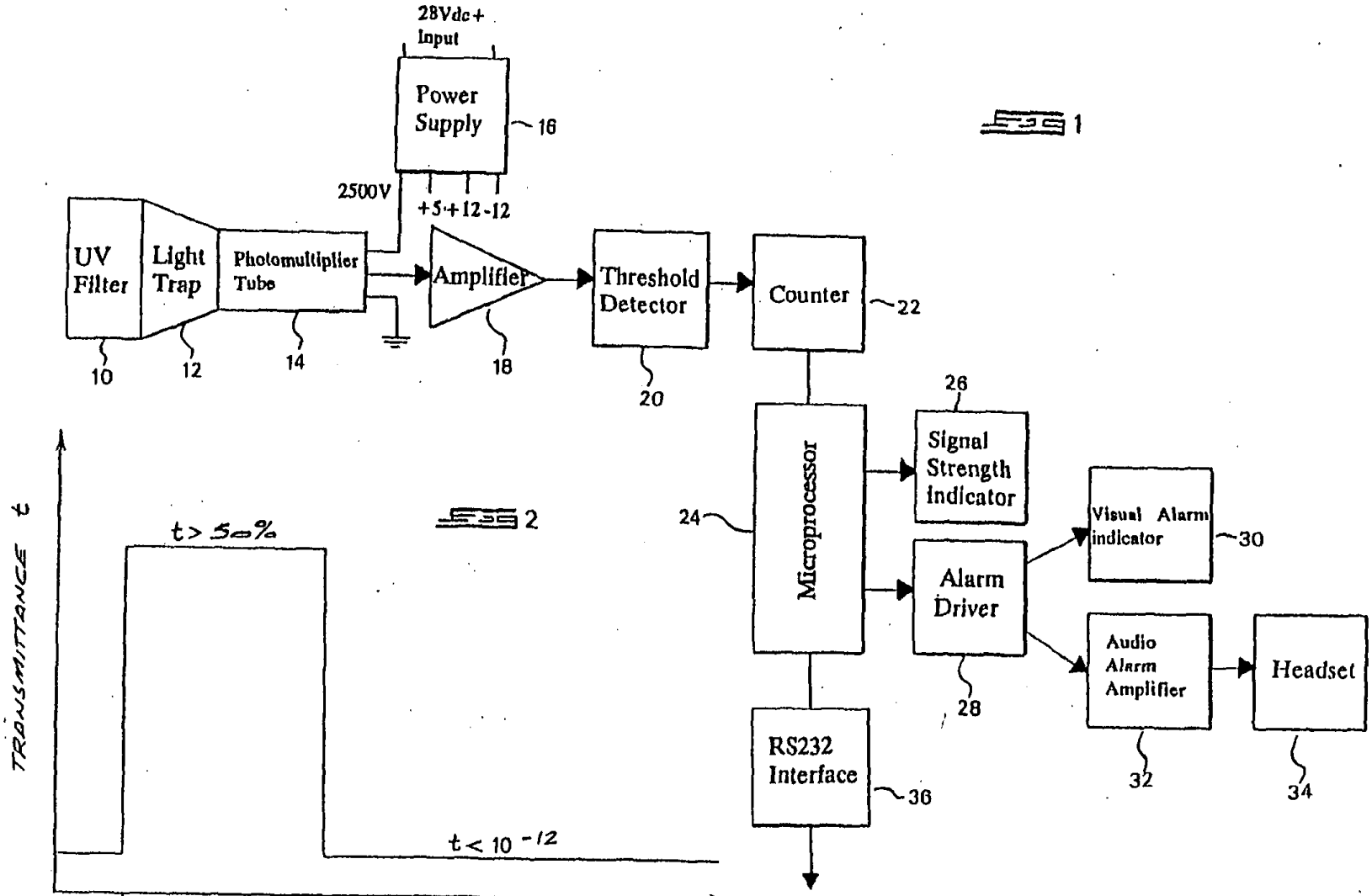
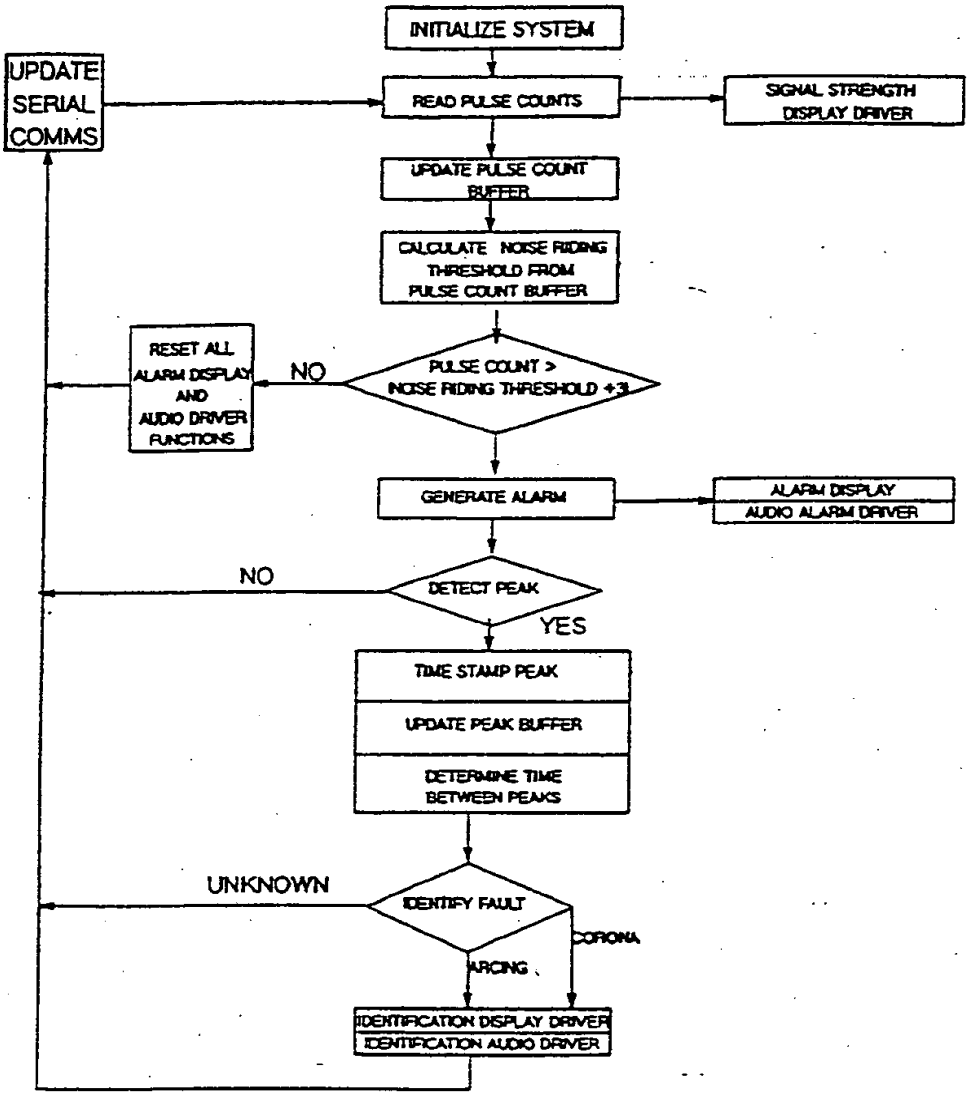

28Vdc+
Input
Power
Supply
16
2500V
+5 +12 -12
UV
Filter
Light
Trap
Photomultiplier
Tube
Amplifier
Threshold
Detector
Counter
22
10
12
14
18
20
26
Microprocessor
24
Signal
Strength
Indicator
Visual Alarm
indicator
30
Alarm
Driver
Audio
Alarm
Amplifier
Headset
28
32
34
RS232
Interface
36
TRANSMITTANCE t
t > 50%
t < 10 -12
200nm
240nm
270nm
700nm
WAVELENGTH nm

FIG 1

FIG 2


INITIALIZE SYSTEM
UPDATE SERIAL COMMS
READ PULSE COUNTS
SIGNAL STRENGTH DISPLAY DRIVER
UPDATE PULSE COUNT BUFFER
CALCULATE NOISE RIDING THRESHOLD FROM PULSE COUNT BUFFER
RESET ALL ALARM DISPLAY AND AUDIO DRIVER FUNCTIONS
NO
PULSE COUNT > NOISE RIDING THRESHOLD +3
GENERATE ALARM
ALARM DISPLAY
AUDIO ALARM DRIVER
NO
DETECT PEAK
YES
TIME STAMP PEAK
UPDATE PEAK BUFFER
DETERMINE TIME BETWEEN PEAKS
UNKNOWN
IDENTIFY FAULT
CORONA
ARCING
IDENTIFICATION DISPLAY DRIVER
IDENTIFICATION AUDIO DRIVER

OPTICAL DETECTION OF ELECTRICAL DISCHARGES

This invention relates to apparatus for detecting electrical discharges, such as corona discharges on high voltage power lines.

The detection of certain electrical discharges on power lines, such as corona discharges on conductor insulation and leakage, can be difficult. Such discharges are generally invisible in daylight and rarely generate sufficient heat for thermal detection. Discharges of this type may be visible at night, but night time inspection generally precludes the use of helicopters, increasing the inspection time unacceptably.

According to the invention apparatus for detecting electrical discharges from an electrical conductor comprises:

filter means adapted to pass energy in the ultra-violet portion of the spectrum and to block ambient solar energy;

a photomultiplier device for detecting ultra-violet energy passed by the filter means;

amplifier means for amplifying an output of the photomultiplier device;

discriminator means for monitoring the amplified output of the photomultiplier device, for detecting signals corresponding to electrical discharges and for generating an output signal corresponding thereto; and

indicator means responsive to the output signal to generate a discernible indication of the electrical discharges.

Preferably, the discriminator means comprises a threshold detector which rejects signals from the photomultiplier device below a first threshold and/or above a second, higher threshold.

In further preferred embodiments, means are provided to integrate the output of the threshold detector over a predetermined period of time, thereby to provide an averaged output signal.

The indicator means may comprise an analogue meter or other visible indicator device, and/or an audio signal generating device.

Embodiments of the present invention will now be described by way of example, with reference to the accompanying figures, in which;

Figure 1 is a simplified block schematic diagram of apparatus for monitoring electrical discharges according to the invention;

Figure 2 is a graph indicating the characteristics of an optical filter of the apparatus; and

Figure 3 is a simplified flow chart illustrating the operation of the apparatus.

The illustrated apparatus is used for detecting electrical discharges on powerlines and relies on an ultra-violet filter 10 which passes ultra-violet light with a transmittance of 50% or greater, while substantially blocking longer wavelength light, with a wavelength longer than 290 nm. Since solar energy at low altitudes is filtered by the ozone layer and contains very little light energy having a wavelength shorter than 290 nm, apparatus using the filter is effectively "blind" to ambient solar energy. The response of the filter 10 is shown in the graph of Figure 2.

The filter 10 is fitted to the front of a light trap 12 which is fitted to a photomultiplier tube (PMT) 14 with a high voltage power supply 16. The PMT has a gain of approximately 1 000 000 and generates output pulses which are typically 20 ns wide with an amplitude of less than 2 mV. The output of the photomultiplier tube is applied to an amplifier 18 which amplifies the pulses to a level of approximately 100 mV.

The output of the amplifier 18 is fed to a threshold detector 20 which has upper and lower thresholds defining a window between them. The amplitude of each input pulse is compared to the threshold levels by means of a pair of fast comparator circuits. The upper threshold is set to discriminate against pulses due to incident cosmic rays, which have a greater amplitude that pulses produced by photons from corona or partial discharges. The lower threshold is set to reject pulses due to thermal emissions, which are lower in amplitude than the pulses due to corona or partial discharges. The output of the threshold detector 20 is a series of TTL-level pulses of constant amplitude and duration, corresponding to each detected pulse which falls within the detection window of the threshold detector.

The output of the threshold detector 20 is fed to a sixteen bit counter 22 which is controlled by a microprocessor 24. The counter 22 counts the pulses received from the threshold detector over an integration period of, typically, 1 ms, before being reset and repeating the count.

The following functions are executed in the microprocessor 24, under software control. The output of the counter 22 is read by the microprocessor 24, and the output value is compared with the value of a dynamic noise riding threshold. The value of the noise riding threshold is determined by the average of a 32 bit shifting register of previous counts. If the output value of the counter 22 exceeds the value of the noise riding threshold by more than 3 counts, which means that a peak is detected, the value of the dynamic noise riding threshold is kept constant until the output value of the counter is less than 3 counts above the value of the noise riding threshold.

The time is measured between the peaks detected in this way. If more than one peak is detected within a time span of 40 ms the alarm function is enabled. If the peaks occur at intervals of 20 ms, the discharge on the power line which is responsible for the peaks is identified as a Corona discharge. This is based on the fact that a Corona discharge occurs at every second half cycle of the 50 Hz power line frequency. Obviously, with a different power line frequency, the time between peaks due to a Corona discharge will alter accordingly. If the detected peaks occur at 10 ms intervals, the discharge is identified as arcing.

The magnitude of the detected peaks is output to a signal strength indicator 26, which displays the magnitude on a LED bar graph display. This enables an operator to monitor the peak signal strength visually, which assists in locating the source of the detected discharges.

Alarm and identification information is sent from the microprocessor 24 to the alarm driver 28, which generates the necessary signals to operate a visual alarm indicator 30. The alarm driver 28 also sends signals to an audio alarm amplifier 32, which generates an audio tone which is applied a headset 34, and also for a helicopter intercom system, to alert an operator of the apparatus to the detection of a discharge.

The apparatus includes an RS232 serial interface 36 to enable the microprocessor 24 to communicate with an external computer, thus allowing the recording of data corresponding to detected discharges.

The described apparatus can be mounted in a helicopter and can operate in broad daylight, allowing electrical discharges in over head power lines to be located quickly and accurately.

CLAIMS

1.

Apparatus for detecting electrical discharges from an electrical conductor, comprising:

filter means adapted to pass energy in the ultra-violet portion of the spectrum due to electrical discharges and to block ambient solar energy;

a photomultiplier device for detecting ultra-violet energy passed by the filter means;

amplifier means for amplifying an output of the photomultiplier device;

discriminator means for monitoring the amplified output of the photomultiplier device, for detecting signals corresponding to electrical discharges and for generating an output signal corresponding thereto; and

indicator means responsive to the output signal to generate a discernible indication of the electrical discharges.

2.

Apparatus according to claim 1 wherein the discriminator means comprises a threshold detector which rejects signals from the photomultiplier device below a first threshold and above a second, higher threshold.

3.

Apparatus according to claim 2 wherein the output of the threshold detector is integrated over a predetermined period of time to provide an averaged output signal.

4.

Apparatus according to claim 3 wherein the output of the threshold detector comprises a series of pulses which are fed to an integrator comprising a counter, the counter being configured to count the pulses from the threshold detector over the predetermined period of time.

5.

Apparatus according to claim 3 or claim 4 wherein the discriminator means includes processor means arranged to compare the integrated output of the threshold detector with a noise riding threshold which is obtained by averaging the integrated output of the threshold detector over a long reference period.

6.

Apparatus according to any one of claims 1 to 5 wherein the discriminator means is arranged to determine the nature of a monitored electrical discharge from the period between detected discharges.

7.

Apparatus according to any one of claims 1 to 6 wherein the indicator means comprises a visual indicator arranged to indicate the magnitude of a detected discharge.

8.

Apparatus according to any one of claims 1 to 7 wherein the indicator means comprises an audio signal generating means.

9.

Apparatus according to any one of claims 1 to 8 wherein the filter means operates by blocking light with a wavelength greater than 290mm.

10.

Apparatus for detecting electrical discharges on power lines substantially as herein described and illustrated.

Patents Act 1977
Examiner's r port to the Comptroller under Section 17 (The Search Report)

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Relevant T chnical fields

(i) UK Cl (Edition L) G1A (AHC, AHP, AHS, AMS)

(ii) Int Cl (Edition 5) G01J

Search Examiner
S J MORGAN

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search
3 AUGUST 1993

Documents considered relevant following a search in respect of claims 1-9

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	US 5021668 (TECHNION) - see whole document and lines 33-43, column 3 in particular	1
A	US 4898465 (MEDICAL) - see lines 14-40, column 1	1
A	US 4516022 (ASEA) - see whole document	1

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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